



Future Electricity Markets

Pinson, Pierre

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The changing face of energy production in Europe necessitates a rethink in the way that electricity markets are structured. The '5s' (Future Electricity Markets) project is a multi-disciplinary project that is looking to challenge the current approach to the design and operation of electricity markets as penetration of renewable energy sources increases



Future electricity markets

Renewable energy generation is on the rise in a big way. 2014 saw record levels of deployment of both solar and wind technology, with countries motivated by mitigation of climate change and security of supply. The transition from today's oil-and-coal-dominated world into the envisaged green future will not necessarily be easy, however. As the energy production

2020, it aims to provide Danish power systems with the proper market mechanisms to cope with such a change. These mechanisms will be based in an advanced optimisation framework, from the base methodological developments to the practicalities of their implementation (for instance requiring a parallel computing environment).

drive prices down, which will make investing in appropriate technology for the future less attractive for investors. So it is important that once we understand this impact, we then look to see if we can come up with new ideas in terms of market design to improve things."

Pinson and his team have collated a huge number of datasets to create a simplified version of the entire European transmission network. Data from meteorological institutes has allowed them to model forecasts and measurements for renewable energy production over a period of several years. By combining this with economic and technical information about the energy-producing units from across Europe, they have created a simulation that allows them to look at various outcomes, such as changes in revenue and changes in power flow. It also allows them to test the effects of coupling the markets in different ways.

Assembling the datasets has made up a large part of the work so far. Developments in the electricity market have led to greater transparency, and greater transparency has led to more accessible data, but the sheer volume of this data has been tricky to deal with at times. "There

"The first thing that needs to be assessed is what impact the introduction of these new types of energy producing technologies will have on the existing markets"

landscape changes, the operation and design of energy markets will need to evolve just as quickly in order to accommodate the dynamic and uncertain nature of renewable energy sources.

The 5s project aims to provide both a scientific and technical core for future models of pricing and exchanging electricity. Based in Denmark, which has set itself the ambitious objective of achieving 50 per cent renewable energy by

Preparing for a renewable future

"The first thing that needs to be assessed is what impact the introduction of these new types of energy producing technologies will have on the existing markets," says Professor Pierre Pinson of the Technical University of Denmark and coordinator of the 5s project. "There will inevitably be some negative sides to the impact. For instance, increased levels of solar and wind will have a tendency to



is so much information out there that it is sometimes difficult to know how to manipulate it in a way that can give you new insights," he says. For the data that is not available, there are a number of statistical methods that can be used to fill in the gaps.

Future electricity markets

The design of Europe's energy market currently uses simplified zones that don't truly represent the transmission network used for sharing electricity. Using these simplified zones comes at a cost, however. In countries such as the US, the transmission network is represented as accurately as possible, with prices set at every node of the network. It is possible that by using a system such as this in the future, Europe could cut losses in social welfare. Pinson and his team have been attempting to quantify the potential loss in social welfare that arises from using the current system, and have been simulating whether other systems could be more effective as more renewables are introduced.

Pinson is keen to help facilitate the introduction of disruptive technologies

and ideas into the energy market, but the very nature of the market means that this will likely be a fairly slow process. "One thing you have to remember is that at the European level, the integrated electricity market has to go through a lot of compromise to achieve consensus among all members, which makes bringing disruptive ideas in fairly difficult," he explains. "This is made even more difficult when you consider that the electricity market is actually not entirely linked to the actual operation of the system. Finally, the present lack of understanding about the effects of bringing renewables into the system makes it harder to agree upon a solution. Academics are giving conflicting opinions about the best course of action, which makes the likelihood of decision makers acting upon their ideas less likely."

Changing behaviour, changing market

As the evidence piles up about the negative effects of excessive consumerism on the planet, there is a growing trend towards actively making lifestyle changes to try and counteract the damage being caused. Renewable energy sources are now being rapidly introduced, but the next real paradigm shift could occur in terms of demand rather than supply. 'Prosumers' – those who produce electricity themselves via solar panels etc. but also consume – have been talked about a lot, but changes in how and when energy is consumed could prove to be even more disruptive. If the behaviour of consumers of energy alters significantly, the market will be forced to alter itself to accommodate them.

Encouraging people to change their behaviour is not easy, however. Pinson and his colleagues have been working on another project that is helping consumers become more proactive by using automated technology that reacts to the changing price of energy or controls a building's heating. "The problem you find is that even if you fully automate something for someone, they still want to play with it and adjust it!" says Pinson. "People do not like to think that their comfort is being affected, so it is a challenge to try and maintain changes in behaviour." ★



AT A GLANCE

Project Information

Project Title:

'5s' – Future Electricity Markets

Project Objective:

Ambitious objectives in terms of renewable energy generation will inevitably induce a paradigm shift in the way electric energy is produced, exchanged and consumed. Future electricity markets must be able to optimally deal with the dynamics and uncertainties of renewable energy generation, as well as with dynamic and flexible offers on the demand side. They should fairly re-distribute the increase in social welfare while providing enough returns to electricity producers for them to make appropriate investments. It is the core objective of the '5s' project to forge the scientific and technical core for such future electricity markets to become a reality

Project Duration and Timing:

1.4.2013 until 1.10.2017 (4 years 1/2)

Project Funding:

Danish Council for Strategic Research, 11MDKK

Project Partners:

Technical University of Denmark, University of Copenhagen, Copenhagen Business School, Energinet.dk, Danish energy Association, Norwegian University of Science and Technology

MAIN CONTACT



Prof. Pierre Pinson

Pierre Pinson is a Professor at the Centre for Electric Power and Energy (CEE) of the Technical university of Denmark (DTU). He holds a M.Sc. In Applied Mathematics and a Ph.D. In Energetics from Ecole de Mines de Paris (France). His main research interests are centered around the proposal and application of mathematical methods for electricity markets and power systems operations, including forecasting. He has published extensively in some of the leading journals in Meteorology, Power Systems Engineering, Statistics and Operations Research.

Contact:

Tel: +45 2398 3221

Email: ppin@dtu.dk

